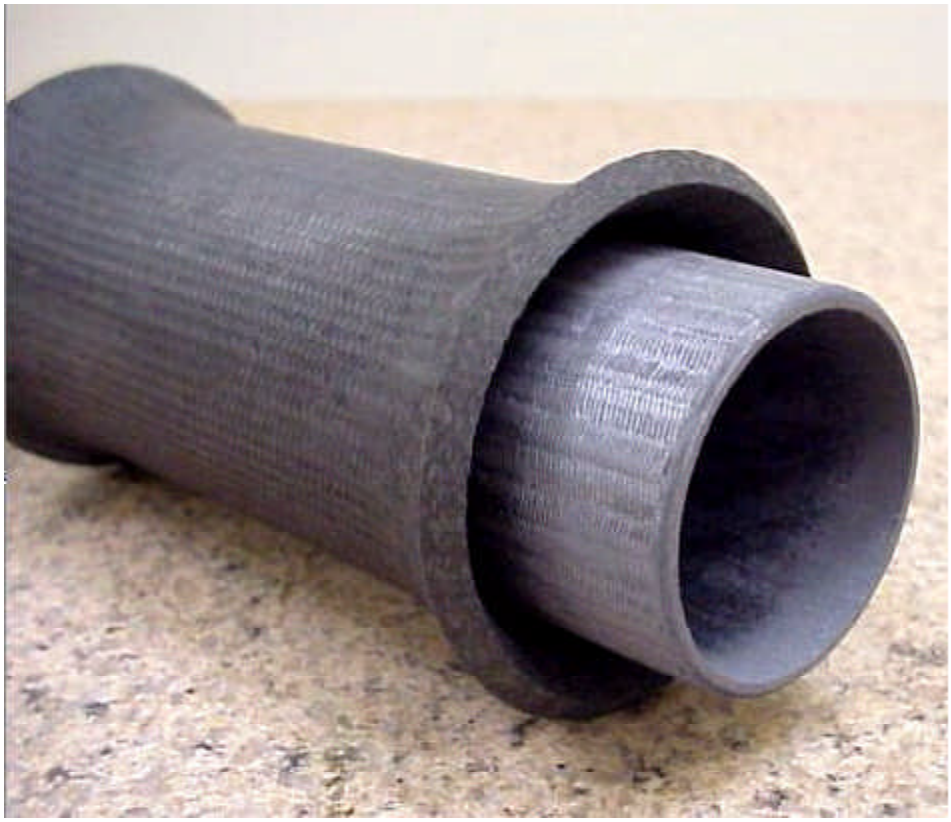
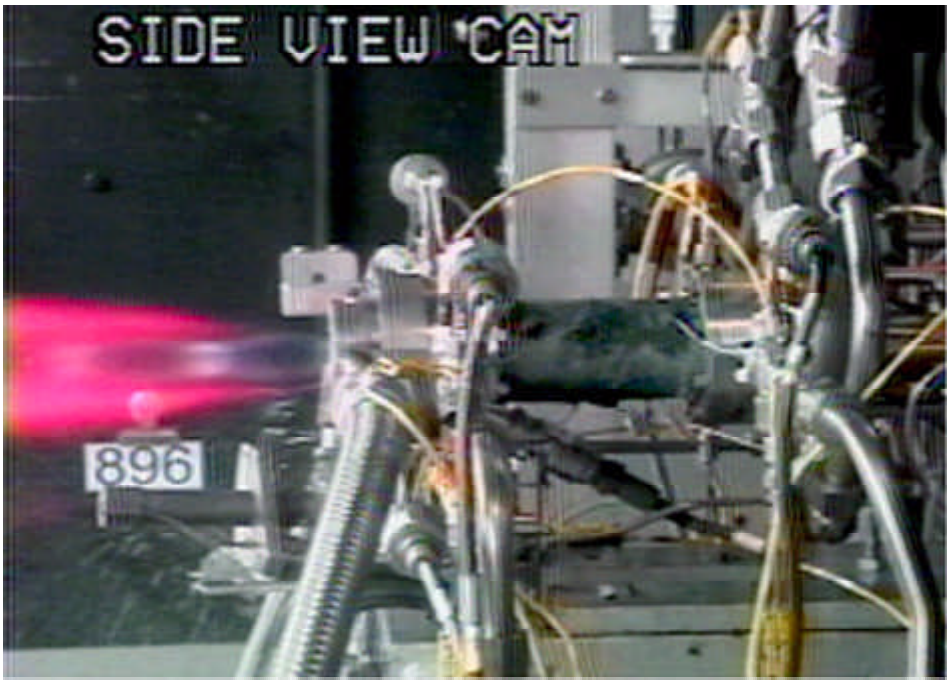
Uncooled C/SiC Composite Chamber Tested Successfully in Rocket Combustion Lab



Uncooled C/SiC melt-infiltration composite cylinders.



Uncooled C/SiC melt-infiltration composite being hot-fire tested.

In a joint effort between the NASA Glenn Research Center, the NASA Marshall Space Flight Center, Material Research and Design, Inc., Boeing Rocketdyne, and GE Powers Systems Composites, an uncooled carbon-fiber-reinforced silicon carbide (C/SiC) ceramic matrix composite (CMC) was developed and successfully tested in Glenn's Rocket Combustion Lab. CMCs offer the potential for substantial weight saving over traditional metallic parts. When uncooled, an additional savings in weight can be achieved because the complex structures associated with the cooling system can be reduced. Several designs were considered, including a double-walled, braided CMC chamber exhibiting permeability at -12 to -13 log Darcy's constant.

On the basis of gas-permeability considerations, the double-walled, braided design was selected for hot fire testing. This design consists of two C/SiC melt-infiltration composite cylinders in coaxial formation joined to a metal injector and nozzle component. The braided architectures of the inner and outer cylinder, respectively, were configured to address the design needs for hoop and axial load integrity. The cylinders were fabricated by GE Powers Systems Composites, formerly known as Honeywell Advanced Composites, Inc.

The CMC combustion chamber was hot-fire tested in Glenn's rocket combustion laboratory. The objective of this test was to assess the CMC combustion chamber's performance under rocket firing conditions. Of particular interest were the hot gas permeability through the composite walls and the structural integrity of the chamber. Testing was conducted in a gaseous O_2/H_2 environment. The test matrix included an oxygen-to-hydrogen ratio of 1.5 for 14 runs with chamber pressures ranging from 100 to 1000 psi. Steady-state internal wall temperatures of the inner cylinder were in excess of 2600 °F, with the outer cylinder's outer wall temperatures averaging 1000 °F for

successful 10-sec runs.

The tests demonstrated that the hot gases could be contained inside the CMC combustion chamber without permeating through the CMC walls. The tests also demonstrated the structural integrity of the CMC combustion chamber under rocket firing conditions.

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